Tájökológiai Lapok 6 (3): 295–310. (2008)
DOI: 10.56617/tl.4171

AN INVESTIGATION OF THE COASTAL EROSION CAUSES IN SAMOS ISLAND, EASTERN AEGEAN SEA

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Keywords: coastal erosion, Samos Island, wave action

Summary: The geomorphological processes, which take place on the coastal zone, are influenced by a number of environmental factors, such as lithology, climate, biota, and oceanography. The present study investigated the causes of erosion taking place on the beach zones and on the coastal cliffs along the Island of Samos (eastern Aegean Sea). On the northern part of the island the coastline is characterised mainly by rocky and craggy coasts with the beach zones to be limited and in the form of a 'pocket' type of beach, while on the southern part by wide and long beach zones constituted by cobbles and pebbles. Intense coastal erosion takes place mainly on the rocky coasts on the northern and especially on the northwestern part of the island. In some coastal places intense coastal erosion causes problems not only to the infrastructure (road network), but also to near-coast people's properties. Coastal erosion is more intense on the northern coasts, than on the southern coasts, due to the differenced in the incoming wave energy, which is dominated by the more intense and frequent blowing northerly winds. Furthermore, it seems that coastline retreat is more often along parts of the coast consisting of marles, malry limestones and limestones.

Introduction

Coasts are by far the most important of all the natural boundaries on the earth. They are the dividing line between the continents and the sea, and as such they undergo different physical, chemical and biological process (AHNERT 1998). Coastal areas have historically been proven to be of great importance to the man. In Greece 1/3 of the population lives no farther than 2 km from the coastline, whilst 85% of the population is established at a distance of <50 km from the coast. Besides, Greece has a great number of populated islands that host the majority of the touristic activities especially during the summer period (POULOS 1998).

The geomorphological processes taking place on coastal landforms are influenced by a number of environmental factors, notably geological, climatical, biotical, as well as oceanographical; such as waves, currents, tides and sediment transport. These vary from one sector of the coast to another, the variation being zonal in terms of climatic regions (in a global scale), and irregular in terms of geological outcrops (BIRD 1984).

The geological factor related mostly to the evolution of an erosional coast, is represented by the structure and lithology of the rock formations, which compose the hinterland, the coast and the near shore zone. The climatic factor is important in terms of weathering of coastal rock outcrops. Rocks are decomposed or disintegrated by such processes as repeated wetting and drying, solution by rainwater, thermal expansion and contraction and freeze-thaw alternations, all related to temperature, precipitation and evaporation regimes in the coastal environment. Wind also is an important factor in coastal evolution, as it generates the waves which subsequently form near shore circulation pattern.

Common problems in coastal zone management have been recognized to be related to un-planned or miss-planned development, decline of traditional and environmental friendly socio-economic sectors, coastline retreat (beach erosion) and lack of appropriate transport networks, particularly on islands. It has also been adopted that a successful coastal zone management should be based upon a better understanding of the natural processes that are referred to both terrestrial (BAKOS et al. 2008) and marine environment.

The present contribution investigates the causes of the extended coastal erosion taking place in many parts along the coastline of the Samos Island, which is located in eastern Aegean Sea, threatening the prosperity of littoral villages and destroying near-sea infrastructures (e.g. road network).

Coastal erosion must be distinguished from other erosion forms occurring on arable lands (DEMÉNY and CENTERI 2008, POTTYONDY et al. 2007, CENTERI et al. 2008) or other landforms (e.g. pastures, forests etc.). Investigation methods used on other, general geographic areas (EVELPIDOU 2006) might not be sufficient to use for the description of coastal erosion or to predict its extent.

Study area

Geographical setting

The Samos Island, situated in the Eastern Aegean Sea (Figure 1.), is one of the biggest and most important Greek islands in the Aegean, having a population of approximately 42,000 inhabitants.

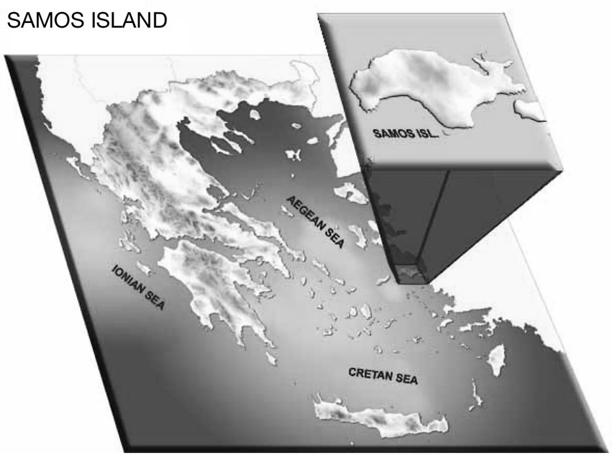

Figure 1. The location of the wider study area.
1. ábra A vizsgált terület tágabb környezete

It covers an area of 476 km^2, having a coastline of 159 km. It is very close to the coast of Asia Minor (Turkey), with the strait that separates the island from the Minor Asia is approximately 1200 m wide and less than 100 m deep; the later means that prior to the last sea-transgression (some 20,000 ago) when sea-level was about 120 m lower than today, the island was connected to the mainland of Asia Minor. The western part of Samos Island hosts the highest mountain of all the Aegean islands, the Kerkis Mountain with an altitude of 1434 m. Furthermore, its northern coast is characterised by steep slopes which give high cliffs on the coastline and a rapid sea-floor deepening offshore. To the south, coasts are gentler and the coastal bathymetry is shallower.

The climate of the island is temperate. The mean annual air temperature reaches 18.4 °C, whereas the mean air temperature on July is 28.4 °C and on December 10.3 °C. The prevailing winds during the year are northerly reaching mean annual intensity 10.81 knots. The mean annual rainfall reaches 709 mm. Maximum rainfall is usually recorded in December (164.0 mm) and minimum rainfall is usually recorded in July (0.5 mm). Relative humidity over Samos reaches 60.38%.

Geological setting

Samos Island belongs to the geotectonic unit, known as Aegean crystalline-schist zone, which is impeded between Atticoclycladic complex and Menderes' crystalline-schist zone (W Turkey). The Pre-Neogene substrate of the island consists of five tectonic units containing marbles, dolomites, quartzites, phyllites, metamorphosed basic to ultrabasic rocks, and a younger nape of diabases, peridotites, cherts and limestones (PAPANIKOLAOU 1979; THEODOROPOULOS 1979). During Upper Miocene two major lacustrine basins were developed, namely the Karlovassi basin in the western part and the Mytilini basin in the eastern part of the island. In Pliocene, both basins, as well as a small basin located about 5 km southeast of the city of Samos, were filled by travertine limestone and claystone of freshwater origin. The deposits of both basins are presumed to be continental depositional faces of Upper Miocene to Pliocene in age (DERMITZAKIS and PAPANIKOLAOU 1981).

The tectonic structure of Samos Island is characterised by tangential movements and in particular nappes placement. Moreover, neotectonic movements are typical, accompanying with plastic deformation resulting to isocline folding of various directions, as well as fragmental deformation, with NNW-SSE main direction, which took place mostly in Pleio-Quaternary and lead to the transversal cutting up on the Neogene basins.

Lithologically, the biggest part of the island is occupied by Quaternary sediments, marles and marly limestones, found mainly in the two aforementioned major lacustrine basins (Figure 2.).

Limestones and marbles, as well as schists and eruptive rocks are found on the western edge and on the central part of the Island, where there are high mountains. Especially in the central part marbles occur as intercalations or great banks of various thicknesses within schists. These lithological formations often represent steeper slopes.

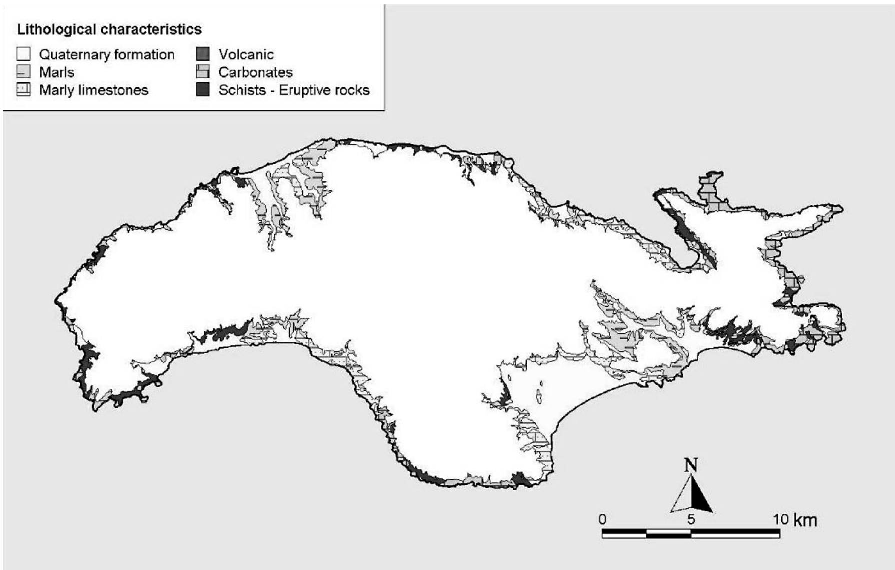

Figure 2. Lithological map of Samos coastal zone
2. ábra Samos-sziget tengerparti zónájának földtani térképe

Geomorphological setting

The island may be divided into three geomorphological units. The first geomorphological unit is located on the western and central part of the island and is characterised by intense relief and steep slopes (Figure 3.). As expected the drainage network has numerous but short sectors. On that area the watersheds are sharp and plains are absent.

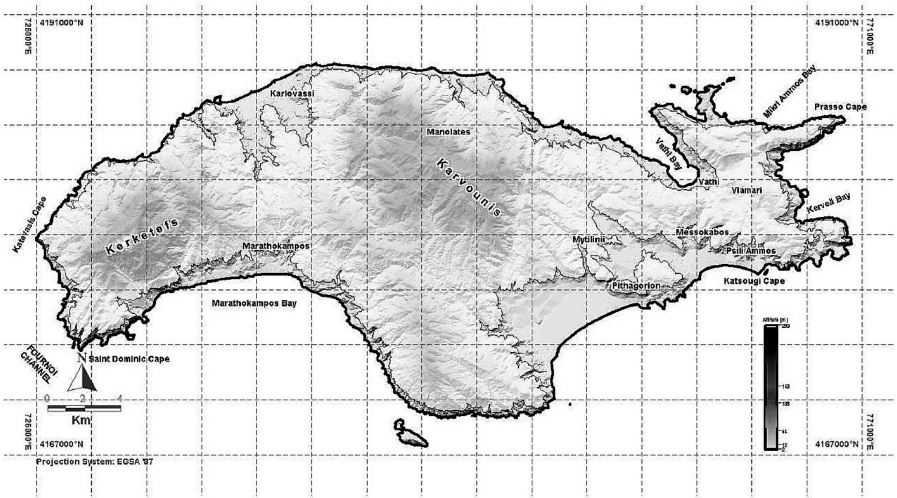

Figure 3. Relief map of the study area.
3. ábra A vizsgált terület domborzati térképe

The second geomorphological unit is located on the central-western, central-eastern part of the island, where the two major lacustrine basins are located, as well as a small basin located about 5 km southeast of the city of Samos. It is characterised by gentle relief, low slopes and drainage networks with long sectors. The plains of the island are found in this unit and specifically mainly near the coastline.

Finally, the third unit is located on the eastern part of the island. It is characterised by medium slopes and medium relief. Steep slopes are also noticed, probably the result of tectonism. The drainage network acquires numerous sectors and the watersheds are gentle. In the third geomorphological unit, a site protected by Natura 2000 is found. The wetland of Alyki is located in the eastern part of the island, close to the coast of Asia Minor and has a wider ecological significance, as it is a rare ecosystem for the Aegean islands (Figure 4.).

Figure 4. The wetland of Alyki (nature conservation area for bird nesting and feeding) is on the eastern part of the island
4. ábra Az Alyki sós, mocsaras területe (természetvédelmi terület a madarak fészkelése és táplálkozása érdekében) a sziget keleti szélén

In the first and third geomorphologic units, intensive karstification takes place, leading to the development of numerous caves with impressive stalactites and stalagmites.

Materials and methods

Topographic maps, the geological map and the hydrographical chart were digitised and imported into a GIS environment (MapInfo Professional, v. 8.5). The altitudinal data were processed using a data aggregation algorithm and a “triangulation with smoothing” algorithm to construct a digital elevation model (DEM) of the coastal area.

Morphological data were mapped through photo-interpretation. These data were confirmed, corrected and enhanced through extensive fieldwork that took place in 2003, 2005, 2007 and 2008. All the collected data were imported into a GIS, where their quantitative, qualitative analysis and the development of various thematic maps took place.

Data collection concerning the coastal geomorphology was completed through extensive fieldwork with the combined use of GPS and GIS. During field work all sites of coastal erosion were mapped and they have been attended since 2003.

Concerning the coastline of the area, aerial photos were corrected, georeferenced and finally imported to the GIS in order to give the corresponding coastline per time interval. For each year different GIS layers were developed in order to depict the coastal zone changes, by combining these different layers. The change in the landforms is also shown on the information layers, while the layer which corresponds to the data from the satellite image shows their current extent.

Average and maximum possible wave conditions (height, period, energy flux) that approach the shore zone of the selected studied areas have been calculated on the basis of predicted values of offshore significant wave height and period using CERC (1984) relevant equations and wind data taken from the Wind & Wave Atlas, of the North-eastern Mediterranean Sea (ATHANASSOULIS and SKARSOULIS 1992).

Results and discussion

Coastal morphology

Coastal morphological slopes analysis showed that coastal slopes are mainly gentle (Figure 5., Figure 7.), since a large part of the coastal zone comprises of Quaternary sediments. Coastal cliffs are recorded mainly at the north coasts, where the high cliffs and steep slopes of the inland continue offshore. At the northern part of the island, the sea floor drops off rapidly, whereas to the south, the seafloor is relative shallow. Very low slope values up to 20% are recorded mainly near the coastline, where the islands torrents discharge developing coastal plains.

The biggest part of the northern coastline consists of rocky and craggy coasts with the beach zones to be limited and in the form of a ‘pocket’ type of beach, while the sandy beaches are limited. On the contrary, the southern part of the island is characterized mainly by wide and long beach zones constituted by cobbles and pebbles. The coastal area mainly consists of limestones and marbles (42.47%) and Quaternary sediments (26.5%). The rest consists of schists and eruptive rocks (15.57%), marly limestones (13,16%), marles (2%), and finally volcanic rocks (0.02%), (Figure 8.).

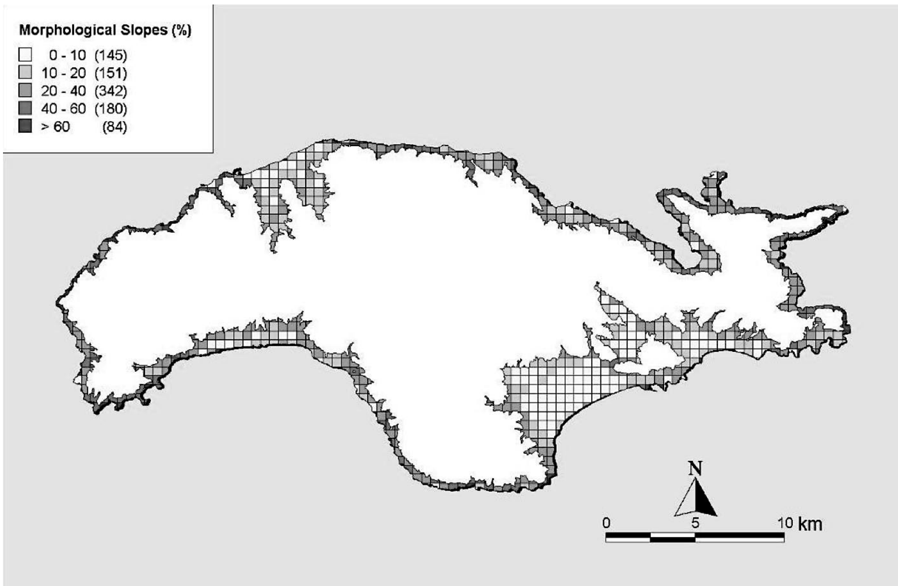

Figure 5. The morphological slopes of Samos coastal zone
5. ábra Morfológiai lejtők Samos-sziget parti zónájában

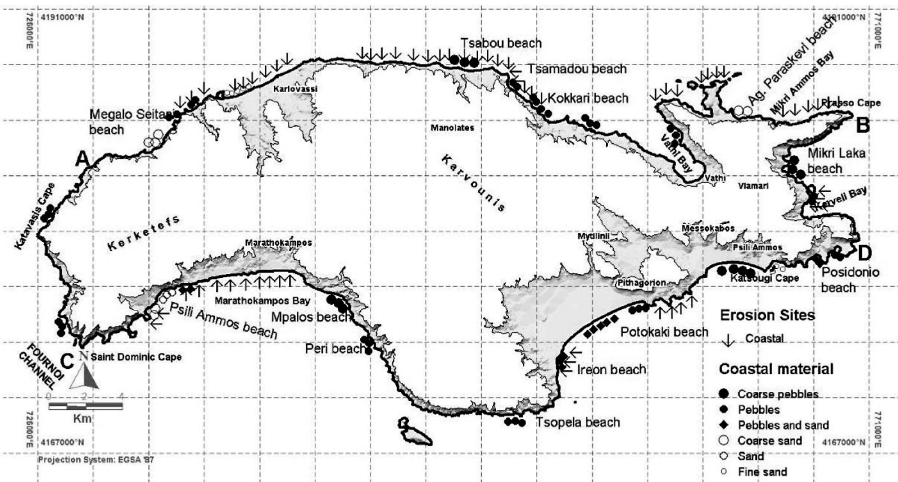

Figure 6. Coastal geomorphological map (arrows show the areas of intense coastal erosion)
6. ábra A part geomorfológiai térképe (a nyilak az intenzív erózió helyét jelzik)

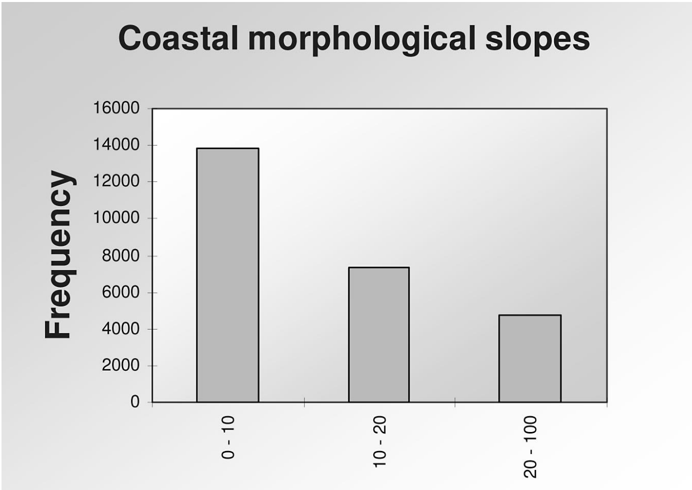

Figure 7. Coastal morphological slopes analyses
7. ábra A tengerparti morfológiai lejtők elemzése

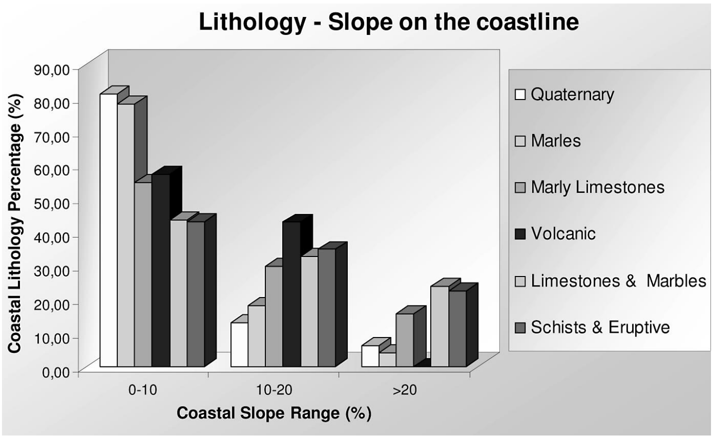

Figure 8. The coastal lithology in relation with the coastal morphologic slopes
8. ábra A tengerpart geológiájának és morfológiai lejtőinek kapcsolata

In the first geomorphological unit the beaches are formed in front of cliffs or in front of torrents' mouths as this unit is characterised by steep slopes (Figure 6.). Specifically, nine cases were mapped in this unit, with the beach zones to be limited and in the form of a 'pocket' type of beach and four cases of beaches which were formed on the torrent's mouth. The beaches in this unit are consisted by sand up to coarse pebbles, but most of the cases are comprised of pebbles. Psili Ammos and Limnionas beaches, which are formed on the torrents' mouths, on the SW part of the island, are comprised by sand and coarse sand respectively. In reverse, Potami and Tsabou beaches which are formed on the torrents' mouths, on the NW and north-central part of the island, are comprised by pebbles and coarse pebbles respectively and experience intense coastal erosion.

In the second geomorphological unit, where the two major lacustrine basins are located, the beaches are mainly formed on coastal plains and are wide and the coastal material is finer, constituted by fine sand, pebbles or mixed coastal material (Figure 8.).

Finally, in the third geomorphological unit, beaches with a variety on coastal material were mapped, while most of the beaches are constituted of pebbles (Figure 8.). Coastal erosion is less intense on these cases.

Wave conditions

The wave characteristics have been calculated for the four locations (A, B, C & D) shown on Figure 8. Wind induced waves are more frequent from the north directions with annual frequencies higher than 55%, when the occurrence of south waves is <35% (Table 1). Furthermore, the highest waves (>6m) approach from the NW and SW directions due to extended wave fetches. The most frequent waves, for the four locations under investigation, are those related to wind speeds of 13.5 knots, having heights <1m and periods <4.5 sec, respectively; an exception to this are the NW incoming waves which present higher values.

Table 1. Mean annual frequency (f, %) of occurrence of offshore waves with calculated period (T, sec) and significant height (Hs, %) for the four coastal locations shown on Figure 6, on the basis of wind data (U wind speed in knots) and their relevant fetch distances (given in parenthesis for each wind direction)
1. táblázat A tengerparti hullámok évi átlagos frekvenciája (f, %) a számított időtartammal (T, sec) és a szignifikáns magassággal (Hs, %) a széladatok (U, szélsebesség csomóban) és a meghatározó érkezési távolságuk (zárójelben feltüntetve minden szélirány mellett) alapján, a négy helyszínre, amelyet a 6. ábra mutat

A (NW point)									
	N (37.5 km)			*NE (30 km)*			*NW (75 km)*		
U	*f*	*Tp*	*Hs*	*f*	*Tp*	*Hs*	*f*	*Tp*	*Hs*
2	0.57	0.80	0.02	0.34	0.80	0.02	0.77	0.80	0.02
5	2.06	2.47	0.22	0.76	2.68	0.26	2.82	2.47	0.19
8.5	3.65	3.58	0.56	0.97	3.33	0.51	5.24	4.50	0.80
13.5	5.77	4.32	1.00	1.09	4.01	0.89	8.30	5.43	1.41
19	5.04	4.96	1.52	0.64	4.61	1.36	5.54	6.24	2.15
24.5	3.52	5.50	2.08	0.26	5.11	1.86	2.50	6.92	2.94
30.5	1.58	6.02	2.72	0.19	5.59	2.43	0.85	7.56	3.85
37	0.64	6.51	3.45	0.04	6.04	3.08	0.25	8.18	4.88
44	0.08	6.98	4.27	0.00	6.48	3.82	0.06	8.77	6.04
S/Av	*22.19*	*4.74*	*1.32*	*15.84*	*3.95*	*0.85*	*26.33*	*5.62*	*1.57*

Contd. Table 1.
Az 1. táblázat folytatása

B (NE point)

	N (30 km)			*NE (30 km)*			*E (22.5 km)*			*NW (213.75 km)*		
U	*f*	*Tp*	*Hs*	*f*	*Tp*	*Hs*	*f*	*Tp*	*Hs*	*f*	*Tp*	*Hs*
2	0.57	0.80	0.02	0.34	0.80	0.02	0.39	0.80	0.02	0.77	0.80	0.02
5	2.06	2.68	0.26	0.76	2.68	0.26	0.68	2.44	0.23	2.82	2.47	0.19
8.5	3.65	3.33	0.51	0.97	3.33	0.51	0.95	3.03	0.44	5.24	4.74	0.69
13.5	5.77	4.01	0.89	1.09	4.01	0.89	1.00	3.65	0.77	8.30	7.67	2.38
19	5.04	4.61	1.36	0.64	4.61	1.36	0.43	4.19	1.18	5.54	8.82	3.63
24.5	3.52	5.11	1.86	0.26	5.11	1.86	0.20	4.65	1.61	2.50	9.77	4.96
30.5	1.58	5.59	2.43	0.19	5.59	2.43	0.07	5.08	2.11	0.85	10.68	6.49
37	0.64	6.04	3.08	0.04	6.04	3.08	0.01	5.50	2.67			
44	0.08	6.48	3.82	0.00	6.48	3.82	0.00	5.90	3.31			
S/Av	*22.90*	*4.40*	*1.18*	*4.29*	*3.95*	*0.85*	*3.73*	*3.42*	*0.63*	*26.33*	*7.94*	*2.64*

C (SW point)

	S (266.25 km)			*SW (105 km)*			*SE (30 km)*		
	f	*Tp*	*Hs*	*f*	*Tp*	*Hs*	*f*	*Tp*	*Hs*
2	0.40	0.80	0.02	0.28	0.80	0.02	0.31	0.80	0.02
5	1.19	2.47	0.22	1.13	2.47	0.19	1.14	2.68	0.26
8.5	1.81	4.74	0.81	1.50	5.03	0.95	1.61	3.33	0.51
13.5	1.86	8.25	2.66	1.64	6.07	1.67	1.43	4.01	0.89
19	1.08	9.48	4.05	0.77	6.97	2.54	1.24	4.61	1.36
24.5	0.90	10.51	5.53	0.46	7.73	3.48	0.66	5.11	1.86
30.5	0.51	11.49	6.25	0.17	8.45	4.55	0.44	5.59	2.43
37	0.00			0.09	9.14	5.77	0.10	6.04	3.08
44	0.00						0.04	6.48	3.82
S/Av	*7.75*	*8.44*	*2.85*	*6.04*	*5.98*	*1.59*		*4.15*	*0.98*

D (SE point)

	S (22.5 km)			*SE (48.75 km)*			*SW (30 km)*			*W (7.5 km)*		
U	*f*	*Tp*	*Hs*	*f*	*Tp*	*Hs*	*f*	*Tp*	*Hs*	*f*	*Tp*	*Hs*
2	0.40	0.80	0.02	0.31	0.80	0.02	0.28	0.80	0.02	0.60	0.80	0.02
5	1.19	2.44	0.23	1.14	2.47	0.19	1.13	2.68	0.26	2.69	1.70	0.13
8.5	1.81	3.03	0.44	1.61	3.91	0.64	1.50	3.33	0.51	4.12	2.11	0.25
13.5	1.86	3.65	0.77	1.43	4.71	1.14	1.64	4.01	0.89	4.47	2.54	0.45
19	1.08	4.19	1.18	1.24	5.41	1.73	0.77	4.61	1.36	2.12	2.92	0.68
24.5	0.90	4.65	1.61	0.66	6.00	2.37	0.46	5.11	1.86	1.04	3.24	0.93
30.5	0.36	5.08	2.11	0.44	6.56	3.10	0.17	5.59	2.43	0.27	3.54	1.22
37	0.13	5.50	2.67	0.10	7.09	3.93	0.07	6.04	3.08	0.12	3.83	1.54
44	0.02	5.90	3.31	0.04	7.61	4.87	0.02	6.48	3.82	0.02	4.10	1.91
S/Av	*7.75*	*3.74*	*0.83*	*6.99*	*4.87*	*1.26*	*6.04*	*3.95*	*0.85*	*15.46*	*2.48*	*0.41*

On Table 2 the totals of the mean annual energy flux (wave power) for the four locations (A, B, C & D) are listed and compared with respect to the lower estimated value (17.8 103 W/m) referred to the point C (SE part of the Samos Isl.). It is shown clearly that the north coast of the Samos Island (points A and B) experience much higher wave power (4.5–6 times higher than the southern coast). This is explained by the longer wave fetches and the persistence of the northerly blowing winds, which for the summer period (May to October) are known as Etesians.

Table 2. Mean annual energy flux (wave power. 103 W/m) of the incoming waves for the four coastal locations shown on Figure 6 and normalised totals with respect to the smallest value
2. táblázat A beérkező hullámok évi átlagos energiaáramlása (hullám erő (103 W/m)) a 6. ábrán bemutatott helyszíneken, és a normalizált összegek a legkisebb érték figyelembevételével

		NW point			
N	*NE*	*NW*		*Total*	*Normalised*
23.6	22.8	56.3		82.2	4.6
		NE point			
N	*NE*	*E*	*NW (1/2)*	*Total*	*Normalised*
21.9	22.8	9.5	98.0	10.1	5.7
		SW point			
S (1/3)	*SW (1/2)*	*SE (1/2)*		*Total*	*Normalised*
26.1	82.8	25.9		36.7	2.2
		SE point			
S	*SE*	*SW*	*W*	*Total*	*Normalised*
36.35	98.6	32.3	11.3	17.8	1

Coastal Erosion

Intense coastal erosion takes place on several coastal areas on Samos Island, on all lithological formations but basically on areas covered by limestones, marles and marly limestones. Coastal erosion takes place in all geomorphological units but it is more intense in the second one, as expected since it comprises with susceptible to erosion geologic formations (Figure 8.).

As far as, the first geomorphological unit is concern, coastal erosion is more intense on the central northern coast, which comprises with Quaternary sediments, and alternations of schists and carbonate rocks. Due to the alternations the geologic formations obtain more weakness surfaces, which make the formation prone to erosion processes.

Coastal erosion is more intense on the northern coasts, than on the southern one; this is due to the annual intensity and existence of the northerly winds blowing and the relatively shorter wave fetches, especially in the case of the eastern coast of the Samos Island. Furthermore, along the southern coast, coastal erosion has been partially initiated by anthropogenic interferences (Figure 9.); the later include reductions the transporting capacity of several torrents discharging along the coast and the various constructions along the coastline i.e. the coastal road.

Figure 9. Coastal erosion causes problems to the southern part of the island as well.
Characteristic example is the littoral road in front of the airport which suffers of intense erosion.
9. ábra A tengerparti erózió a sziget néhány déli partvidékén is problémákat okoz.
Erre jellemző példa a reptér melletti part menti út, amely károkat szenved az intenzív erózió miatt.

Coastal erosion causes many problems to the littoral villages and constructions. A good example of this is the area where the airport is located, on the southern coast of the island, at Pithagorion beach. Pithagorion beach has an NE-SW direction and is a typical example of coastal retreat destroying the littoral road (Figure 9.). The coastal zone from Karlovassi's port (Cavo Shoino) up to Fourniotiko torrent's discharge is characterised by intense coastal erosion. The coastal area consists of easily eroded material coming from Fourniotikos and Megalo Rema torrents. Karlovassi bay has a NE-SW direction and shape of an open hyperbola in alignment to the northern approaching waves, which further induce a westward alongshore sediment transport.

Erosion has also affected the littoral road driving from Kokkari to Karlovassi, which is reached by wave action. Several attempts have been made for the confrontation of erosion constructing vertically to the beach four cobble jetties, which are designed to disperse wave energy and diminish alongshore transport. The westward sediment transport without any significant recovery of the beach zone is demonstrated by difference in beach width on either side of the constructed groins: on their eastern side, deposition takes place, increasing the beach width, while on the western side erosion is more intense decreasing the beach width (Figure 10.).

Intense coastal erosion is taking place as well on coastal zone of Karlovassi bay; the area northern of the Megalo Rema torrent's discharges, where the town's old tannages were located. In this area, is noticeable the fact that nowadays the tannages are found nearly in the wave action zone (Figure 11.), while they were built at a distance beyond wave reach (Figure 12.); this shows that intense erosion has reduced drastically the width of the sub aerial part of the beach.

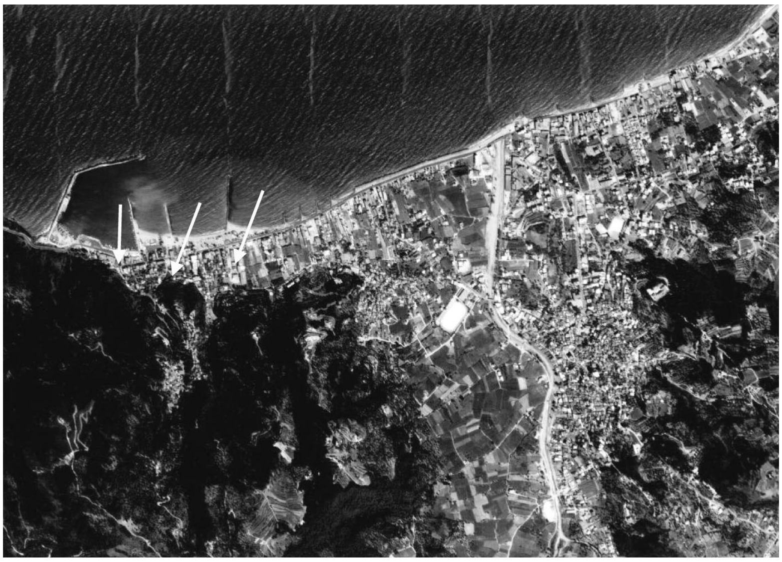

Figure 10. Different sediments on both sides of the jetties. On the eastern part, deposition of sand and gravels is noticed (arrows), whereas on the western part erosion and beach's length decrease is apparent
10. ábra Különböző hordalékok a mólók mindkét oldalán. A keleti részen homok és kavics lerakódásokat láthatunk (nyilak jelzik), míg a nyugati részen az erózió és a partszakaszok pusztulása látható

Figure 11. Erosion of the coastal zone at the old tannages of Karlovassi area, Samos Island
11. ábra A tengerpart eróziójának látható nyomai a régi bőrgyárnál, Karlowassi terület, Samos-sziget

Figure 12. An example of intense coastal erosion at St. Konstantinos area
12. ábra Példa intenzív parti erózióra St. Konstantinos-nál

The only area where sediment is accumulated is the mouth area of the Megalo Rema torrent, indicating that more sediment is provided by the torrent than that the amount removed by wave processes. Apart from this location, the rest of the coastal area of Karlovassi Bay undergoes substantial erosional problems with the cornice being under immediate danger to be destroyed, while the continuous shortening of beach width threatens touristic development of the area. Therefore, engineering works which will protect the coastal zone are necessary in conjunction with a better understanding of coastal environmental natural conditions.

Conclusions

The coastal area mainly consists of limestones, marly limestones and marbles (57.91%), quaternary sediments (26.5%) and schists and eruptive rocks (15.59%). On limestones, marly limestones and marbles a large number of beaches are formed constituted mainly of pebbles or coarse sand. On quaternary sediments a wide range of the coastal lithological sediment were observed varying from coarse pebbles to fine sand. The number of beaches found on schists and eruptive rocks was limited and the coastal material was constituted by pebbles or mixed sediment (pebbles and sand).

On the northern coasts the steep slopes of the inland continue offshore forming coastal cliffs. The biggest part of the northern coastline consists of rocky and craggy coasts with the beach zones to be limited and in the form of a ‘pocket’ type of beach, while the sandy beaches are very few. On the contrary, the southern part of the island is characterized mainly by wide and long beach zones constituted by cobbles, pebbles and sand. For example, Potami and Tsabou beaches, found on the north-central part of the island, are comprised by pebbles and coarse pebbles respectively and experience intense coastal erosion. In reverse, Psili Ammos and Limnionas beaches found on the SW part of the island, are comprised by sand and coarse sand respectively.

The wave characteristics calculations showed that the waves, which are induced by wind, are more common from the north directions. The north annual frequencies of the waves were estimated higher at about 20%, than the ones observed on the southern parts. In addition, the highest waves approach from the NW and SW directions due to extended wave fetches. Moreover, the mean annual energy flux (wave power) calculations showed that the northern coasts of the Samos Island accept much higher wave power, up to 4.5-6 times higher than the one on the southern coasts.

Finally, the northern coasts of the island are characterised by the annual intensity and existence of the northerly winds blowing and the relatively shorter wave fetches, along with the alternations the geologic formations, which obtain more weakness surfaces, making the formation prone to erosion processes.

On the contrary, on the southern coasts, the beaches are mainly formed on coastal plains and are wide constituted by fine sand, pebbles or mixed coastal material. Moreover, the mean annual energy flux (wave power) calculations showed that the lower estimated value referred to the SE part of the Samos Island. Additionally, along the southern coast, coastal erosion has been partially initiated by anthropogenic interferences, which result to reductions to the transporting capacity of several torrents discharging along the coast.

Thereby, coastal erosion is more intense on the northern coasts, than on the southern one, while on the southern coasts; coastal erosion is mainly due to anthropogenic interferences. Intense erosion phenomena that experiences the Island of Samos and especially the northern coast is a combination of the lithological characteristics with the waves action processes.

Acknowledgments

The project is co-funded by the European Social Fund and National Resources – (EPEAEK II) PYTHAGORAS, and we would like them for this financial support.

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TENGERPARTI ERÓZIÓ HATÁSÁNAK VIZSGÁLATA SAMOS-SZIGETEN, AZ ÉGEI-TENGER KELETI SZÉLÉN

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A tengerparti zónában fellépő geomorfológiai folyamatokat többféle környezeti hatás befolyásolja, mint pl. a kőzet, az éghajlat, az élővilág és a tenger. A tanulmány az Égei-tenger keleti részén fekvő Samos-szigeten vizsgálja az erózió hatását a parti zónában, mind a sík (homokos és kavicsos), mind pedig a meredek, sziklás részeken. A sziget északi partvonalán sziklaszirtek jellemzőek, a sík tengerparti zóna nagyon korlátozott méretű, zsebszerűen alakult ki, míg a déli oldalon széles és hosszú sík parti zóna található kisebb vagy nagyobb kövekkel. Intenzív parti erózió elsősorban a sziget északi, elsősorban az észak-nyugati sziklás részén figyelhető meg. Néhány parti területen a nagymértékű erózió problémákat okoz az utak beomlasztásával, de sérülnek a parton élők telkei is. Az északi és a déli oldal közötti intenzitásbeli különbség a beérkező hullámok energiájának különbségének köszönhető, melyet az erős és gyakori északi szelek okoznak. Ezen kívül megfigyeléseink alapján a leggyorsabb part hátravágódás a márgával, a márgás mészkővel és a mészkővel jellemezhető partszakaszokon a legerősebb.